"TOXIC POVERTY" – IMPROVING MATERNAL, INFANT AND CHILD HEALTH

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"Toxic poverty" – improving maternal, infant and child health in contexts of high adversity

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CURRICULUM VITAE

Professor Mark Tomlinson is based in the Department of Psychology at Stellenbosch University and received his PhD in Psychology from the University of Reading in the United Kingdom. He is a Visiting Professor in the Department of Psychiatry and Mental Health at the University of Cape Town.

His scholarly work has involved a diverse range of topics that have in common an interest in factors that contribute to infant and child development in contexts of high adversity, and how best to prevent compromised infant and child development in these contexts. He has completed research investigating the impact of maternal depression on infant and child development.

He has also completed four large randomised controlled trials, all of which have examined the impact of interventions delivered by community health workers on maternal and child health. He is on the editorial boards of PLoS Medicine and Psychology, Health and Medicine, and is an Associate Editor of the Infant Mental Health Journal.

He currently is one of two research directors of the Programme for Improving Mental Health Care (PRIME). PRIME is a consortium of research institutions and ministries of health in Ethiopia, India, Nepal, South Africa and Uganda. He has received research grants from the Wellcome Trust (UK), the National Institute of Alcohol Abuse and Alcoholism (NIAAA) (USA), the National Institute of Drug Abuse (NIDA) (USA), the Department for International Development (DfID) (UK), the Swedish International Development Agency (SIDA), and from Grand Challenges Canada. Mark is the husband of Natasha, and the father of Sebastian and Benjamin.

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INTRODUCTION

In 2011, the global under-five mortality rate was 6.91 million, and while this signified a significant reduction from the 11.97 million children under five dying in 1990, most of these deaths continue to occur from preventable causes and almost all in low- and middle-income countries (LAMIC) [1,2]. While mortality is the most commonly used metric to illustrate the stark contrast between rich and poor countries, more than 200 million children under the age of five fail to reach their developmental potential. This has been linked to multiple risks such as poverty, poor nutrition, lack of educational opportunities, maternal depression and under-stimulating home environments [3]. Following Shonkoff and colleagues I use the term 'toxic poverty' to describe the impact of chronic poverty on child development in the absence of the buffering impact of nurturing environments and relationships [4]. The imperatives of chronic poverty, poor health systems and a lack of human resources demand a focus on the implementation of appropriate models of sustainable community-based care to reach the poorest families.

In this paper I will outline the current state of maternal and child health, both globally and in South Africa. This will be followed by a discussion of the proximal and distal determinants of poor health, in which I will make a case for ensuring that the broader determinants of ill health are also seen within a framework of the power relations in society. I will then examine three community-based randomised controlled trials that colleagues and I have implemented over the last decade that utilise a community-based task-shifting approach. I will then briefly discuss the findings of these three studies, with the aim of outlining the lessons for the implementation and scale up of community-based interventions in South Africa.

THE GLOBAL CONTEXT OF MATERNAL, INFANT AND CHILD HEALTH

In 2008, 1.29 billion people lived on less than $1.25 a day [5]. While this is an improvement on the 1.91 billion in 1990 and the 1.94 billion in 1981, at the current rate of improvement about one billion people will still be living in extreme poverty in 2015. In the fifty years since the end of World War II, the world beyond North America and Western Europe saw significant improvements in health care and living conditions [6]. There have been improvements in life expectancy, the eradication of smallpox, lower infant mortality rates, better access to safe water, the availability of health-care services, and improving levels of literacy in LAMI countries. This improvement is misleading, however, in that, due to population growth, the actual number of people living in poverty has hardly changed. The worst 'performer' has been sub-Saharan Africa, where almost 50% of the population lives in extreme poverty [5].

The last two decades have seen significant improvements in maternal and child health, with reductions of 35% for child mortality and 34% for maternal mortality [7]. While neonatal deaths (those occurring in the first month of life) have also seen significant reductions (17% fewer since 2000), they still account for 40% of all under-five mortality [8]. In 2010, over three million newborns died in the first month of life, while the reduction in neonatal mortality has been slower than for mortality in children aged one to 59 months [8]. These improvements are welcome, but it has been estimated that the seven million annual deaths of children under five could be averted if existing low-cost interventions were scaled up to all children [7].

The figures for maternal, neonatal and child mortality are dramatic, but as Hertzman and colleagues point out, the adverse environments in which infants and children are dying are the same environments in which many more infants are living [9]. In the seminal Lancet series on Child Development, Grantham-McGregor and colleagues conservatively estimated that, because of poverty, poor health and nutrition, and environments that do not provide the needed nurturance for infants and children, at least 200 million children under the age of five fail to reach their developmental potential [3]. Children who are not cared for in nurturing environments with adequate nutrition and stimulation are more likely to have poor levels of education and reduced earnings later in life [3]. Early stressors leave characteristic imprints on cognition, immune function, stress responses and gene transcription, that later have an impact on psychosocial functioning and on physical and mental health [10,11]. Shonkoff and colleagues have used the term 'toxic stress' to describe a form of stress response that occurs when the child's stress response system is activated for a prolonged period of time, together with an absence of a supportive caregiving relationship that can buffer the stress [4]. If this early toxic

stress is not reduced it can lead to irreversible changes in brain function and structure [12,13]. I would argue that environments characterised by chronic poverty are toxic in terms of the way they can 'get under the skin' [14] and lead to the loss of developmental potential.

SOUTH AFRICAN CONTEXT

South Africa is a middle-income country, but one that is characterised by gross inequities. This is reflected in the marked difference in child and neonatal mortality between different groups in South Africa. For example, the infant mortality rate (IMR) is still more than four times higher for the black population than for the white population (47 vs. 11 per 1 000 live births). South Africa is one of twelve countries worldwide where child mortality has increased since 1990 [15]. This is related primarily to the HIV epidemic, with more than half of child deaths attributed to HIV/AIDS [16]. South Africa has the highest number of persons living with HIV globally [17]. Pregnant women in South Africa face intersecting epidemics of HIV, alcohol and drug abuse and malnutrition. HIV+ mothers have challenges caring for their own compromised health, as well as that of their baby.

In addition to HIV, pregnant mothers use alcohol at a hazardous level. South Africa has the highest global per capita alcohol consumption rate [18]. Children of mothers with hazardous, dependent or harmful alcohol use have changes in body and brain morphology, demonstrate deficits in cognitive functioning, verbal fluency, executive functioning, motor development and school achievement, and experience emotional and behavioural problems [30-33]. Even low levels of alcohol consumption have been shown to be related to negative developmental sequelae for babies [19-23]. In South Africa, 8.9% of babies have wasting syndrome and 17% of newborns have low birth weights [24], while post-partum depression rates exceed 30% [25] and are related to having an unplanned pregnancy and a lack of social support [25].

South Africa is one of an increasing number of countries suffering from a quadruple burden of disease – a) infectious diseases, b) malnutrition, c) maternal mortality and, increasingly, d) non-communicable diseases [26]. It has been estimated that the economic consequences of non-communicable diseases will reach $7 trillion – approximately $500 billion per annum – between 2011 and 2025, an average annual loss of $25 per person in lower-middle-income countries and $139 in upper-middle-income countries [27]. On the other hand, implementing population-based measures to reduce tobacco and alcohol use, improve diet and increase physical activity will only cost about $2 billion for low- and middle-income countries ($0.40 per person) [27].

UPSTREAM AND DOWNSTREAM FACTORS – THE DISTAL AND THE PROXIMAL

In theorising about how societal factors or broader political factors influence individual risk and behaviour, public health thinking, particularly in the current era of 'social determinants', has increasingly focused on the concepts of upstream (distal) and downstream (proximal) determinants [28]. Link and Phelan argue that proximate risk factors are the mechanism through which the more distal societal and contextual factors operate [29]. Upstream determinants are defined as features of the environment, such as socio-economic status or levels of discrimination in a society [30]. Downstream determinants, on the other hand, are physical health, parenting and disease. The terms have also been used in theorising about family and interactional factors at the individual and family level. Here, proximal might refer to the minutiae of the moment-by-moment interactions between a mother and her infant, while the more distal factors might refer to the level of support she receives from her partner, or neighbourhood influences such as violence.

For those theorising about this issue, one of the tasks is to determine how upstream determinants or specific social environments "get under the skin" and affect downstream variables such as parenting and infant outcome [30]. Or to state it in a different way, it is a process of trying to understand how poverty (which appears to be a global (distal) variable) comes to influence specific processes in the proximal lives of infants and children [31]. Some have argued that the role of poverty is smaller than that of more immediate factors (partner violence) in, for example, the development of mental disorders [32]. This is a common mistake that assumes that upstream variables are less important [33].

Krieger has argued recently against using the terms proximal and distal in public health conversations about causal pathways because of how the terms have come to be understood [28]. She argues that, as the use of the terms has evolved, proximal factors have come to be seen as those that act directly on or within the body, and therefore to have the greatest effect because they are closer [28]. The distal factors, on the other hand, have been relegated to having less impact because of 'their distance'. Krieger argues that the moment we argue that the distal operates through the proximal (and is not an effect in and of itself), we absolve structural and power factors (e.g. prejudice and extreme inequities in wealth accumulation) of any direct influence, or what she refers to as a 'studied agnosticism' about how one accounts for the range of toxic elements to which infants and children

may be exposed [28]. Politics and inequity have a direct influence on where people live, what toxins they are exposed to, what resources they are able to access and, as a consequence, the patterns of disease distribution to which they are exposed [28]. One of the consequences of a 'studied agnosticism' regarding power and the societal changes required to change population health are the messages we receive (for example) about eating healthier. The way in which the invective is phrased places the driver of change at the proximal (within the individual). In this formulation there is scant regard for the structural changes that need to occur to curtail the power of the multinational food industry, how it shapes and determines food production, and the distribution of and access to cheap food with little or no nutritional value [34,35]. I would argue that an apolitical stance ironically may end up locating 'toxic environments' within the individual, and not within the broader societal context of structural discrimination and inequity.

Another, and more insidious, outcome of this separating of the distal and proximal is that it 'cleaves' rather than connects levels [28], with the result that the individual experience (maternal depression, for instance) may be seen as a result of individual weakness, with associated blame and guilt. Viewing the distal and proximal as levels, and always acknowledging the role of the structural components of risk factors must be a central component of any population-based public health approach.

COMMUNITY-BASED INTERVENTIONS: FROM 'DISEASE TO FAMILY'

Progress towards improving population health and health equity in South Africa depends largely on the scaling up of effective community-based programmes that focus increasingly on pregnancy and the post-birth period, and implementing appropriate models of sustainable community-based care to reach the poorest families. Traditionally, a narrow disease-focused model has dominated health interventions and, to a substantial degree, has been determined by the search for the 'magic bullet' – one intervention (often technical in nature) that will solve the problem (e.g. HIV vaccine). In the last two decades, much of the funding for health interventions globally has been categorical (disease specific), such as for HIV or for malaria. Categorically funded, vertically integrated interventions are costly, often highly stigmatised (HIV or depression), and do not have the capacity to address the health needs of Africa [36]. Claeson and Waldman have argued that significant gains in child survival and improvements in child health will depend to an increasing degree on what happens in the household, in combination with a responsive and supportive health system [37]. They propose a focus on the promotion of a limited number of household behaviours that have a direct link to childhood illness.

A disease-focused (or magic bullet) approach often ignores crucial issues such as coverage, behavioural change and the 'messiness' of family life [36]. In addition, it is prone to ignore unintended or unforeseen consequences. For example, the primary aim of most interventions that target pregnant, HIV-positive women is to prevent mother-to-child transmission. Once transmission has been prevented, the programme considers itself to be successful and usually ends. The failure of the programme to cast a gaze beyond its immediate disease-specific aim has a number of consequences. One recent example of this is the emerging evidence of increased mortality and morbidity among HIV-exposed uninfected infants and children [38]. A broader focus on wellness within a family-based approach would reduce the potential for the broader implications of HIV infection (not simply transmission) to be overlooked. Another example of the limitations of a disease-focused intervention from the parental depression literature is the finding of Seifer and colleagues [39] that poor parenting practices associated with depression may persist following a depressive episode and when the parent is relatively symptom free. This provides further evidence for the need for a broader programme focus than, for example, an intervention that focuses narrowly on parental depression [40].

Children's early experiences and maternal caretaking are primary mechanisms shaping children's functioning, and sustainable strategies are needed for improving these experiences [3]. Globally, the most powerful strategy to date has been a nurse home-visiting programme in the USA for disenfranchised mothers who are experiencing multiple risks [41,42]. The Nurse-Family Partnership (NFP) is a home-visiting programme during the first two years of life. Nurses support mothers and promote problem solving across a range of developmental challenges. In a series of randomised controlled trials (RCTs), the children of unmarried, low-income mothers randomised to NFP were found to have better developmental outcomes up to six years of age, have less contact with the criminal justice system at age 15, and were less likely to smoke in adolescence [43-45]. However, nurses are not a viable or sustainable strategy in LAMI countries and it will be necessary to shift care responsibilities from professional physicians and nurses to trained community health workers (CHWs) (task shifting) [46].

Over the last decade, my colleagues and I have implemented three randomised controlled trials to examine the impact of CHWs conducting home visiting

in order to promote problem solving across a range of developmental challenges:

1. Thula Sana mother-infant intervention – based in Khayelitsha, Western Cape
2. Philani + Mentor Mothers Intervention – based in Khayelitsha, Western Cape
3. Goodstart 3 – based in Umlazi, KwaZulu-Natal

1. The Thula Sana mother-infant intervention

The Thula Sana ('hush baby') project was the first intensive early home-visiting programme using a randomised controlled trial design in South Africa. It targeted early mother infant interaction behaviours. Globally, several trials of early interventions aimed at improving maternal sensitivity and reducing infant attachment insecurity have been conducted. A meta-analysis of 70 intervention studies showed that both maternal sensitivity and infant attachment security were improved [47]. A pilot intervention in Khayelitsha found that, compared to women who had not received an intervention, those who received home visiting from trained mothers from the community were found, six months postpartum, to be more sensitive in their engagement with their infants and to express more positive affect [48].

Thereafter, a randomised controlled trial was undertaken in the same area to test an intervention designed to encourage mothers to engage in sensitive, responsive interactions with their infants. The intervention was delivered by women resident in Khayelitsha with no formal specialist qualifications. They were trained in basic parenting and counselling skills, as well as in the specific mother-infant intervention to be tested. We recruited a total of 449 pregnant women, half of whom received the home-based intervention. The intervention was delivered in hour-long sessions and comprised 16 sessions in total, ending at six months postpartum. The intervention was associated with significant benefit to the mother-infant relationship. At both six and 12 months, mothers in the intervention group were significantly more sensitive and less intrusive in their interactions with their infants compared to the control mothers [40]. The intervention was associated with a higher rate of secure infant attachments at 18 months. The intervention also reduced maternal intrusive and coercive behaviour – behaviours consistently related to poor later outcomes such as the early onset of externalising behaviour [49].

The attachment finding is crucial in that, as Fonagy argues, socialisation to inhibit natural aggression occurs through the development of self-control [50]. Self-control, in turn, requires the development of symbolisation, which itself develops as a function of the mother-child relationship. A poorly functioning attachment system is therefore likely to be instrumental in the development of later aggression and violence [50]. Aggressive children are hypersensitive to threat, falsely attributing hostility to the action of others, and overlook other, more benign contextual factors (an accidental collision, for instance) that may more readily explain the behaviour of another [51,52]. To the best of my knowledge, no study in a LAMIC has yet established whether an early intervention of the kind we have delivered in Khayelitsha is associated with longer term benefits in the child's development. Large-scale cohort studies indicate that insensitive parenting in infancy is predictive of later behavioural problems [53] and cognitive deficits [54]. Further, there is increasingly strong evidence that early attachment security is associated with a wide range of developmental advantages in later childhood [55]. A recent, comprehensive meta-analysis of 69 samples (totalling nearly 6 000 children) showed that attachment insecurity reliably predicts later externalising problems, and that the effect is remarkably persistent over time [56]. Recent work on a large-scale longitudinal study (encompassing over 1 000 American children) has indicated that such effects increase with time, rather than diminish, particularly for children experiencing high levels of social adversity [57].

Secure early attachment is associated with enhanced school performance. There are two potential routes to this. First, longitudinal outcome studies have consistently found that attachment security is associated with improved language development [58], which is itself a predictor of later school performance [59]. Second, the reduction in the rate of externalising problems consequent to secure attachment itself carries benefit in the domain of school achievement [60]. There are, thus, strong grounds for predicting that the substantial improvement in the rate of secure attachment and sensitivity of maternal care produced by our intervention in Khayelitsha will be associated with enhanced long-term developmental outcomes in at least three major domains: externalising behaviour problems, social competence, and school engagement and performance. Our team recently received funding to follow up this cohort of mothers and children at age 13 and to assess these domains of child functioning, as well as to assess whether the early gains seen are associated with long-term developmental outcome.

2. Philani + Mentor Mother Intervention

Philani (a nongovernmental organisation that was initially designed to focus on improving child nutrition) identifies potential neighbourhood CHWs on the basis of their being "positive peer deviants" [61]. 'Peer deviants' are mothers whose children are thriving despite living

in conditions of high adversity. These Mentor Mothers were identified in a three-stage process: 1) referrals by local leaders and stakeholders; 2) observations of supervisory CHWs during training and of trainees' homes; and 3) performance during training (coming on time, keeping notes, demonstrating problem-solving ability and interpersonal competence). Because the Mentor Mother resides in the community, she also becomes a bridge for the mothers to network with her neighbours.

Philani's Mentor Mothers draw their case load from a geographically-defined area, (neighbourhood). We recruited 1 238 pregnant women in 12 matched pairs of neighbourhoods. On average CHWs made six antenatal visits and five postnatal visits between birth and two months post-birth. The neighbourhood Mentor Mothers become sources of social support for their peers on an ongoing basis, making home visits to monitor the baby's progress, providing information and skills relating to alcohol and HIV/TB, as well as making referrals for clinic care on an ongoing basis. The Mentor Mothers work half time (four hours daily), making home visits on four days and attending supervision one day weekly; a supervisor attends the home visits with the Mentor Mother twice monthly. Mentor Mothers systematically visit every home in their assigned neighbourhood, taking with them a scale with which they weigh all children under five years, and use growth charts to identify malnourished children. Messages are also targeted at mothers living with HIV, mothers using alcohol, mothers with underweight babies, mothers needing child financial assistance grants, and provide caretaking and create a social network.

The following messages were targeted at neighbourhood women:

1) Mothers Living with HIV (MLH). Within couples, antenatal testing (96% of women) leads the woman to be the first household member to be identified as HIV+. To counter any stigma (first detected is associated with beliefs about being the first infected) and to avoid the mandate for the MLH to disclose her serostatus, the women in the study were provided with referral letters asking all couples with a pregnant woman to get tested for sexually transmitted diseases concurrently with their partner [49]. MLH need to choose a single feeding method, hopefully breastfeeding. Fear of the critical observations of partners, mothers and mothers-in-law on the feeding method is a significant barrier to a single feeding method. Consistent with government guidelines, we recommend that formula feeding be avoided unless the women have clean water on the premises and enough money to buy the milk on an ongoing basis, especially if clinic supplies are depleted. Strategies in relation to universal precautions for blood spills are reviewed, every woman is encouraged to get her partner tested for HIV, consistent condom use is stressed, and strategies for coping with the partner's alcohol use and multiple partners are addressed.

2) Mothers with Hazardous Alcohol Use. A realistic black baby doll with features of foetal alcohol syndrome (FAS) is presented during a home visit. The characteristics of FAS and life-long consequences of alcohol on babies are discussed. Mentor Mothers are taught how to assess the typical amount of alcohol being used by the pregnant woman and to equate the level of alcohol use with the development of negative behavioural sequelae in their infants. The Mentor Mother screens for alcohol use with the Derived Alcohol Use Disorder Identification Test of the National Epidemiologic Survey on Alcohol and Related Conditions, [62].

3) Nutrition. Post-birth, the Mentor Mother monitors the infant's nutrition over time in all the families (using the scale they carry, as well as developmental charts). The chart shows the expected height/weight for each baby, key aspects of the home environment (e.g. mother is dressed, has fed children, home is neat, children's location is monitored). This chart is updated by the Mentor Mother on each home visit and kept by the Mentor Mother for each family over 18 months. The Mentor Mothers do not distribute food, except in the most dire cases, but help the mother problem solve how and where to get food.

4) Child Financial Assistance Grant. Since 2002, all financially needy mothers are entitled to a monthly government grant that provides a family safety net for their children. Getting the child grant requires presenting an ID card and the baby's birth certificate. Mentor Mothers are trained in "how to work the system" for securing the grant. Philani currently provides social worker back-up to mothers on a routine basis. Mentor Mothers refer the mothers to the Philani social work programme, if necessary, to help complete the paperwork for the child grant.

5) Caretaking, creating a social network. Messages include doing things to care for and enjoy the baby, keeping friends close, and being receptive to help from others. Mentor Mothers are selected on the basis of knowing how to create pleasant and supportive households. Mentor Mothers share their optimism and caring with mothers on an ongoing basis, and will support mothers to notice daily joys in their children and family.

Early results indicate that, in Philani neighbourhoods, mothers report a significantly higher median number of tasks reflecting well-being than mothers in the control neighbourhoods. Similarly, a significantly higher percentage of Philani mothers completed more than the overall median number of well-being tasks than mothers in the control neighbourhoods. Secondarily, a significantly higher percentage of mothers in Philani neighbourhoods reported consistent use of condoms (used condoms in

10 of the last 10 sexual encounters), breastfed longer, and breastfed exclusively (fed no other food, gripe water or traditional medicines to infant for six months). Relative to control mothers, pregnant women living with HIV (WLH) in Philani reported a significantly higher median number of tasks reflecting well-being, and were more likely to adhere to the complete protocol for the prevention of mother-to-child transmission (PMTCT), as well as to take maternal antiretroviral (ARV) medication during delivery; to use only one feeding method for six months; to be free of maternal birth complications (heavy vaginal bleeding, bad-smelling discharge, temperature, persistent cough, breast infection, other); and to have infants who measured greater than -2 SD from the mean WHO standard for infant head circumference-for-age at six months. Among women who previously had a low birth weight (LBW) infant, Philani mothers were significantly less likely to give birth to another LBW infant during this study, compared to control neighbourhood mothers.

3. Goodstart 3

We conducted a cluster randomised controlled trial in Umlazi, KwaZulu-Natal to assess the effect of CHW home visits to pregnant and postnatal women on 12-week infant HIV-free survival, exclusive infant feeding at 12 weeks postnatally, coverage of care, behavioural indicators (antenatal HIV testing, postnatal clinic visit within seven days of life, uptake of cotrimoxazole amongst HIV-exposed infants, family planning uptake) and levels of maternal depressed mood at 12 weeks [63]. The goal of the study was to develop an integrated and scalable home visit package to be delivered by CHWs targeting pregnant and postnatal women and their newborns to provide essential maternal/newborn care, as well as to increase the uptake of interventions for Prevention of Mother to Child Transmission (PMTCT) of HIV and to evaluate the effect and cost of this package [63].

The study site was Umlazi, a peri-urban settlement with a total population of one million, close to Durban, KwaZulu-Natal. The antenatal HIV prevalence in this district in 2010 was 41% [64], and infant mortality was estimated to be 42 per 1 000 live births [65]. The intervention package was designed around data that shows that more than half of neonatal deaths occur in the first two days after birth [66], which means that early postnatal visits are critical. Intervention cluster CHWs were trained over 10 days and implemented the intervention though a structured home-visiting programme consistent with the guidelines of existing PMTCT, Integrated Management of Childhood Illness (IMCI), lactation counselling and newborn care. We used motivational interviewing techniques [67] for breastfeeding counselling. This was based on the belief that knowing what feeding method was preferable might not be related to the ability to implement that choice. Women often have little say when making a final decision about feeding choice in the face of pressure from family members or community stigma [68].

We recruited 3 594 pregnant women from control and intervention clusters. Women in the intervention arm received seven home-based visits: two during pregnancy, and one within 48 hours of delivery, during days three to four and 10 to 14, and during weeks three to four and seven to eight. Low birth weight neonates (< 2 500 g) received two extra visits within the first week. To maximise early postnatal visit coverage, we employed a person in Prince Mshiyeni Memorial Hospital, where over 98% of all Umlazi births take place, to notify CHWs when an intervention group participant gave birth [69]. In the control clusters the CHWs provided information and support on accessing social welfare grants and conducted three home-based visits: one during pregnancy and two during weeks four to six and 10 to 12 post-delivery.

While the CHWs in this study were part of a research study, rather than government-hired and -trained generalist CHWs, every effort was made to ensure that all aspects of the training, implementation and supervision of the CHWs approximated interventions planned by the South African government in their re-engineered primary health-care system. In addition, the package promoted linkages between community-level and existing health systems. We believe that our study has important lessons that inform all levels of the re-engineered system. Implementing an effective scaled up and integrated package for newborn care, PMTCT and infant development using generalist health-care workers in urban informal settings has significant implications for the countrywide integration of programmes.

DISCUSSION

While community-based family-level interventions offer the potential for significant gains, their implementation will face many of the same barriers that individually focused interventions do. Scaling up CHW family-based interventions will need to be linked to existing service delivery systems and integrated with the existing health-care system. In addition, they will require a trained, well-managed and adequately supported workforce in order to deliver the interventions. The broad diffusion of many successful programmes has not happened in any significant way [36]. One of the reasons for poor diffusion is that delivering efficacious treatments under ideal conditions is quite different from implementation at scale in community settings. Interventions are embedded within the "messiness" of family life, the chaos of families

without meaningful routines, and with multiple familial actors that all contribute to both the problem and its solution. Behavioural change can only be sustained when it is supported by the routines and personal relationships that characterise daily family life [36]. These interventions do not exclude a focus on the health system or on specific 'diseases' or health concerns. But what all of them do is to include in programme design an understanding of how any health issue is firmly embedded within a familial context. In the case of infant feeding in the Goodstart 3 intervention, for example, we acknowledge that providing information about exclusive and appropriate feeding, and even convincing HIV-positive women about it, is simply the first step in a complex chain of familial negotiations that will have to take place for the knowledge to become translated into practice. Interventions must address such environmental barriers to implementation.

An element common to all three RCTs was the extremely high number of single mothers. In the Thula Sana trial, 40% of the women were single, while in the Philani + and Goodstart trials the figures were 44% and 87% respectively. The lack of involvement of fathers in the lives of their children is a significant cause for concern in South Africa. Okin's notion of how justice in a society requires a just family, with the labour of child care being shared by both parents, is sobering in this regard [70].

A noteworthy innovation of the Goodstart 3 and Philani RCTs is the utilisation of mobile phones for data collection, as well as for monitoring and supporting the CHWs [69,71]. An important component of scaling up is bridging the gap between small-scale efficacy studies and large-scale interventions. Central in this regard is the building of effective strategies to support the management and supervision of CHWs [72]. The performance of CHWs in achieving their health objectives is influenced by multiple factors, but it is widely accepted that effective supervision is of fundamental importance [72-76]. The difficulties in establishing an effective information system that provides managers with high-quality and timely information about the activities and performance of a dispersed group of workers may be an important cause of the loss of quality in management and supervisory systems as programmes scale up. Supervision and field support are major barriers to consistent, sustained CHW performance [77]. The use of mobile phones provides a strategy for on-going monitoring and routine feedback to CHWs on their progress with families and the quality of their implementation. Both mobile and in-person supervision was provided. This combined approach promises to be an effective means to strengthen implementation strategies for CHWs.

The three studies described above demonstrate the effectiveness of a generalist model for delivering home-based preventive care by CHWs. The Goodstart 3 and Philani + models appear to be sustainable models for home-based support for pregnant women and at-risk children. Preventive services offered by CHWs can supplement an overwhelmed health-care system that cannot meet Africa's health needs, and certainly cannot meet the needs of the range of diseases confronting LAMI countries. This effectiveness of these interventions demonstrates both the value of interventions that target multiple domains, and a strategy for the evaluation of such interventions. In conclusion, these three studies provide strategies for the planning, management and implementation of maternal and child health programmes in South Africa and Africa, and inform the sustainability [78] of the maternal, newborn and child and home-visiting components of the re-engineered primary health care in South Africa. Meeting the health needs of South Africa and Africa in the next two decades will depend on the implementation of evidence-based community and family-centred task-shifting approaches.

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